

Demystifying Molded Capacitors

The Beitman CD project is underway and ordering information is at the end of the column. But this month's column kicks off with the info you'll need to decode those strangely marked mica-molded capacitor values.

A recent foray into a forgotten corner of the "Wireless Connection's" storage area yielded a trove of forgotten postage stamp NOS mica capacitors. It's a large cigar box of them to be exact—probably a flea market find brought home and forgotten years ago. Old timers sometimes refer to these parts "postage stamp" caps, because their rectangular molded cases and size resembles a typical postage stamp in size and appearance.

They were probably stored and forgotten any of several reasons (I may already have had a large selection of new dipped-silver micas sorted in plastic storage bins). But most likely, because decoding the often cryptic color coding systems can be a challenge, I simply didn't want to be bothered at the time. I now decided it would be worthwhile to sort and grade these caps; it's always nice to be able to use reliable NOS parts in keeping with our vintage theme whenever possible.

Fortunately, mica capacitors are among the least likely components to fail; they're also very stable devices. The only caveat is to be aware that some of the larger value molded caps might actually be paper capacitors, which are as failure prone as their wax-paper cousins! It's usually fairly easy to differentiate between the two varieties; the mica capacitor color codes generally begin with a black or white dot (there are exceptions), and the mica capacitors are generally fairly low pF values. I'll show some practical examples later.

The problem is that over the years there were several different marking schemes, each with its own idiosyncrasies! Sometimes, it's hard to decide exactly which code applies to the particular specimen you're trying to decipher. Fortunately, it's often easy to figure out which code is proper by process of elimination. **Table 1** shows the color code

Table 1. Molded Mica Capacitor Color Codes

Color	Digits	Volts x 100	Multiplier	Tolerance
Black	0	0	1	20%
Brown	1	1	10	1%
Red	2	2	100	2%
Orange	3	3	1,000	3%
Yellow	4	4	10,000	4%
Green	5	5	100,000	5%
Blue	6	6	1,000,000	6%
Violet	7	7	10,000,000	7%
Gray	8	8	100,000,000	8%
White	9	9	1,000,000,000	9%
Gold			0.10	5%
Silver			0.01	10%
None				20%

Note: Voltage ratings may not apply to all capacitors.

Table 1 gives a value of 750 for these colors. Continuing clockwise, reading the bottom three color dots from right to left we have gold-gold-brown. The fourth gold dot is a multiplier value of 0.1; 0.1 times 750 yields a value of 75 mmfd for this capacitor. The fifth gold dot indicates a 5-percent tolerance for the EIA marking code. The sixth dot is brown, for a voltage value of 1. Because the rating is in hundreds of volts, the actual working voltage for this device is 100 volts.

marking systems for most of the capacitor examples we'll be discussing.

Obsolete Codes

To read a molded capacitor, orient the body so the color dots can be read in the correct sequence (the markings are read from left to right). There are several vari-

ations for indicating the correct position. The manufacturer's mark or name—if present—will be right side up. Sometimes the dots are stamped on a long arrow, and the arrow head should point to the right hand side. In other instances, one or more of the dots may be slightly "pointed" to indicate the correct orientation. For vintage consumer radios, you'll most



*Photo A. This early mica capacitor uses a simple, but obsolete, RMA 3-dot marking system. With the indicating arrow(s) pointing right, the color-coded dots are read left-to-right as brown-black-brown. According to **Table 1**, this is a 100-mmfd (100pF) capacitor.*

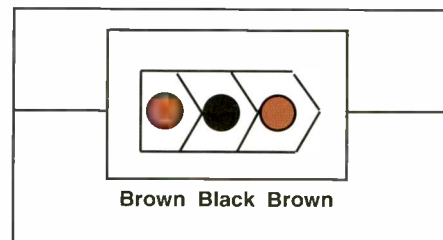


Figure 1. The color dots are orientated with the arrows pointing towards the right-hand side. Reading from left to right, the color code is brown-black-brown, indicating the device is a 100-mmfd capacitor. This cap uses the obsolete RMA three-dot marking system; these capacitors have a 20-percent tolerance and 500-volt rating.

likely encounter molded capacitors using the three-dot marking system.

Early Three-Dot RMA Code

Figure 1 and **Photo A** illustrate an example of a molded mica capacitor that uses the obsolete RMA three-dot code. This part is a Cornell Dubilier molded cap which uses arrow heads to the right of each dot to show the correct orientation. The dot colors are *brown, black, brown*. **Figure 1** shows how to decipher these color-coded markings. This capacitor has a value of 100 mmfd, or 100 pF using modern conventions. In some odd cases, the tolerance may be indicated by the addition of a fourth dot. Otherwise, the capacitor is 20 percent tolerance with a 500-volt voltage rating.

One minor note: In the examples shown in the drawings, the closest color on the drawing palette was used—some of the colors are the nearest examples I could find. For example, *orange* may actually be more red than orange, so read the labels shown on each example in the drawings for the precise color.

EIA, JAN, Or Industrial?

Sigh. Nothing is as easy as it should be! You'd think the color codes for these parts would be universal, but mica capacitors have been marked with many different standards over the decades. Here are just a few we've run across: RMA (Radio Manufacturer Association) using three-, four-, five-, and six-dot marking systems, RMA 1948, JAN (Joint Army Navy), AWS (American War Standard), EIA (Electronic Industry Association), "Commercial," and "Industrial." Whew! How can we keep track of which standard goes with which capacitor? Things aren't always straightforward, and this is where intuition and experience are helpful! And, there are exceptions to every rule.

First, let's take a look at the EIA, MIL (military), and JAN standards used on six-dot molded capacitors. Again, indicating arrows show proper orientation and values are read from left to right on the top row, continuing in clockwise rotation from right to left on the bottom row!

Figure 2 and **Photo B** show some examples of NOS JAN/MIL color-code mica capacitors. Now, if the first dot is *black* or *white*, the capacitor is most likely a mica capacitor. *Black* indicates a MIL or JAN color-coded mica capacitor. If the first dot is *white*, the capacitor like-

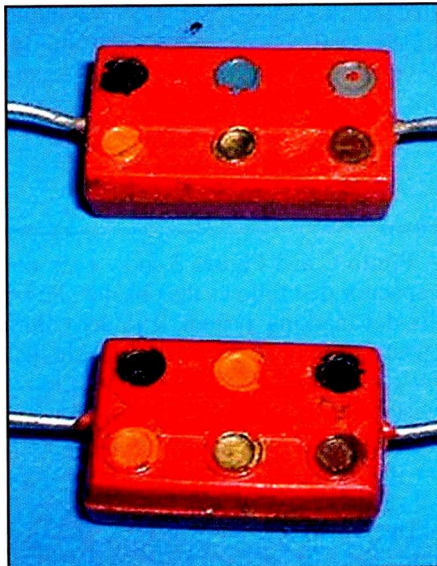


Photo B. Here are two examples of six-dot capacitors, which follow the JAN military marking system. The first dot on both devices is black, indicating a mica dielectric.

ly follows the "modern" 1948 RMA marking code. Except for the differences in available tolerance ratings (again, see **Table 1**), the actual capacitance values would be the same for either MIL or EIA coded capacitors.

Now, the fly in the ointment is this: the *white* dot could indicate a mica capacitor, or it could indicate a first digit capacitor value of 9 for industrial color-coded caps! A *silver* first dot was also used to indicate

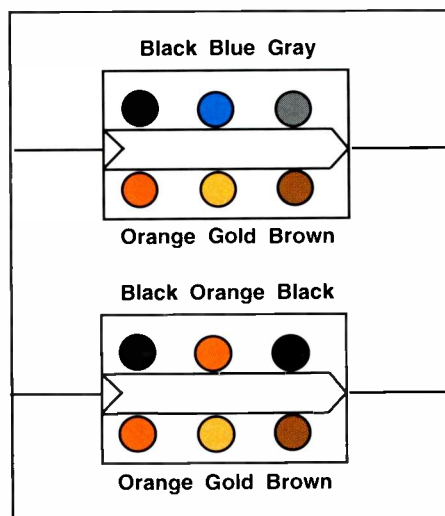
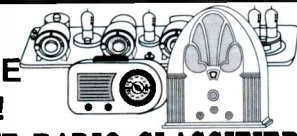


*Figure 2. Reading in a clockwise direction, the color code for the top capacitor reads black-blue-gray-brown-silver-orange. According to **Table 1**, this is a mica capacitor, with a value of 680 mmfd. The silver dot indicates a tolerance of 10 percent; the orange dot specifies the temperature drift tolerance. The second cap has a 300-mmfd value.*



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a molded paper capacitor. A three-dot capacitor in a black body might also be a molded paper capacitor.

The first component in **Figure 2** is a 680-mmfd capacitor. The first dot is *black*, and according to JAN standards this is a mica dielectric capacitor. The first digit value (second dot) is *blue*, for a value of 6, the second digit value (third dot) is *gray*, for a value of 8; and the multiplier dot (fourth dot) is *brown*, for a multiplication of 10x. This gives us a final value is 680 mmfd. The fifth dot (*gold*) indicates a 5 percent tolerance. The sixth dot is a "class" rating for the device.



Photo C. This six-dot mica capacitor uses the obsolete RMA 6-dot marking standard. With the capacitor placed so that the arrows point to the right, the first three dots read violet-green-black going in a clockwise direction.

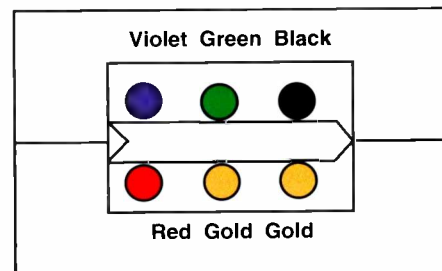


Figure 3. RMA six-dot molded mica capacitor. The color code for this device reads (clockwise) violet-green-black-gold-gold-brown.

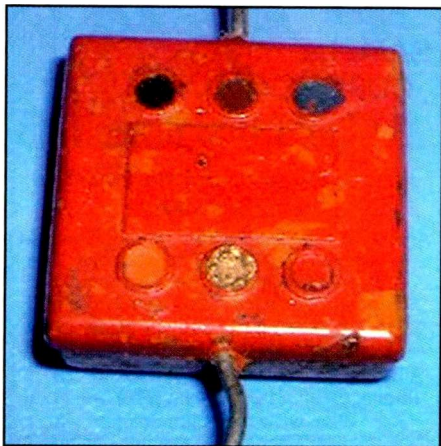


Photo D. The dots read black-brown-green-red-silver-orange. What's the dielectric and capacitance?

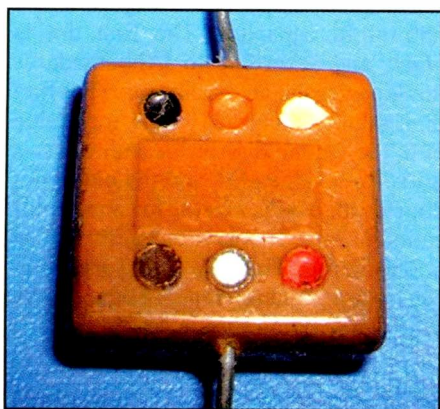


Photo E. The dots read black-orange-white-red-silver-brown. What is the capacitor?

The second example is 300-mmfd capacitor. The color code reads *black, orange, black, brown, gold, orange*. Again, the first *black* digit indicates a mica dielectric. The second and third dots, *orange* and *black*, indicate a value of 30. The *brown* multiplier band indicates a 10x multiplication, thus the capacitor has a value of 300 mmfd. The tolerance is 5 percent, as indicated by the fifth (*gold*) tolerance band. The sixth (*orange*) mark is for the class rating for the capacitor (this last aspect of the rating system is beyond the scope of this article).

Voltage Ratings?

What about the voltage rating for these caps? Often the voltage rating was determined by the size of the case and the by the capacitance value. There are some examples where the voltage rating and other parameters were marked by additional color dots on the backside of the component. It's probably safe to assume

that most caps will have a 500-volt rating unless their values exceed 6000 mmfd. Five-hundred volts is more than adequate for vintage receiver circuits.

Obsolete RMA Six-Dot Code

Photo C and Figure 3 show a six-dot capacitor that follows the obsolete RMA six-dot marking system. The dot colors (from left to right across the top) are *violet-green-black*, and continuing clockwise right to left across the bottom are *gold-gold-red*. Table 1 shows this to be a 75-mmfd capacitor (verified on my digital capacitance meter).

Here's how the code is read: the first three dots decode to a value of 750. The fourth *gold* dot indicates a multiplier of 0.1. Multiplying 750 by 0.1 yields a value of 75 mmfd. The fifth dot, also *gold*, is the tolerance, in this case 5 percent. The sixth and last dot is *red*, indicating a value of 2, and representing the voltage rating in hundreds of volts. Thus, the capacitor has a 200-volt voltage rating.

Practice Drill!

Photos D and E show two other examples of molded capacitors. Can you identify their values using Table 1? Figure 4 shows the physical characteristics of both capacitors.

Bumble Bees!

No, not the insect kind! Some paper capacitors were molded in thin Bakelite cases. Often the values and parameters are printed on the cases, but there are a few varieties that use color bands to denote their values and characteristics. These are rather colorful devices, and the colorful stripped bands over the black bakelite cases bear some resemblance to the stripes on a bumblebee, hence the nickname. These capacitors are notoriously bad and should be changed when encountered in older equipment! One would think the Bakelite case would provide an effective moisture barrier to protect the paper dielectric, but it apparently doesn't.

In any event, Table 2 gives the color codes for these parts, and Figure 5 shows an example of a 4700-mmfd capacitor. The first three bands are the value; in this case, *yellow* (4) *violet* (7) and *red* (2) equate to 4700 mmfd (.0047 mFd). The fourth black band indicates the cap has a

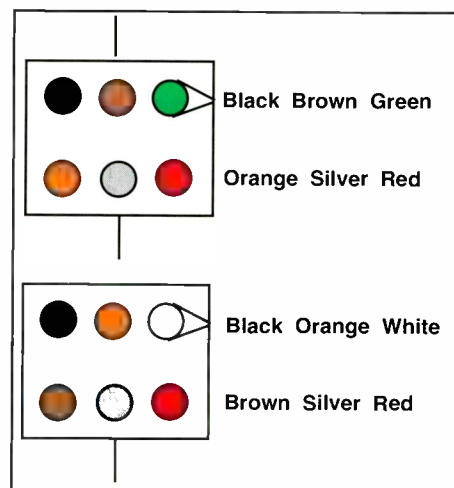


Figure 4. Pictorial drawings for the two "mystery" capacitors. What is the value for both caps, and identify the dielectric.

20% tolerance. The last two bands are the voltage rating in hundreds of volts. For our example, the two voltage bands are *brown* and *blue* (16), the voltage rating for the capacitor is 1600 volts.

Beitmans On CD

Morris Beitman would assemble schematics and service data for the most popular sets sold that year by various manufacturers, and then publish them annually in soft-covered book form. The volumes were inexpensive and very popular since they covered the majority of sets likely to be encountered by the average serviceman or technician. The last volume was for sets made between 1967 and 1969, which pretty much marked the end of the vacuum tube era as well.

Several months ago I mentioned that the Beitman "Most Often-Needed" series of manuals was being scanned and placed on the Internet for downloading at <http://www.eskimo.com/~p0lez1/beitman/beitmanhome.htm>. The ambitious project was entirely due to the generosity of Scott W. Harvey, the gentleman who supplied the time, labor, and Web space to make the digitized versions available for free download and use.

The volumes were scanned and compressed in Djvu format, which means you'll need to have the Djvu browser plug-in installed on your computer to view these files. The entire set of compressed Djvu files takes up over 200 MB of disk space, so downloading it all could present some problems for folks with dial

Table 2. Color Codes For Molded Tubular Capacitors

Color	Digits	Multiplier	Tolerance	Voltage
Black	0		20%	0
Brown	1	10		1
Red	2	100		2
Orange	3	1,000	30%	3
Yellow	4	10,000	40%	4
Green	5	100,000	5%	5
Blue	6	1,000,000		6
Violet	7			7
Gray	8			8
White	9			9

service, or for those who have to pay by the minute for dial line service.

What Is Djvu?

On the website Scott explains how Djvu is a revolutionary form of file compression developed by AT&T. It compresses files to about one sixth their original size, greatly reducing download time. Scott notes that it would not have been practical to offer the manuals for download without Djvu. The volumes are broken down into several smaller compressed zip files, making them manageable for slow dial up connections.

Scott has given us the okay to offer the Beitman volumes on CD, including the Djvu browser and creation software, as a service for our readers whose Internet access is slow or expensive enough to make it impractical to download the *otherwise free files*. Scott will also be offering the Beitman manuals on CD in a higher resolution PDF format at a later date. Check his website for developing information regarding availability or pricing.

Ordering The CD

The Wireless Connection Beitman CD is \$15 for U.S. and Canadian readers. Canadian orders will be sent by parcel post, U.S. orders will be mailed by priority mail. At these prices, I can't guarantee that everyone's computer software or hardware will be compatible with the Djvu browser plug-in software. Some have reported that the Djvu creation software will allow file viewing if the Djvu browser plug-in doesn't. We've had a few test CDs in the field, so far the feedback has been entirely positive. These CDs are being burned on my computer on a one-by-one basis, so don't expect a fancy label or colorful packaging!

To order the CD, please send your request to "Wireless Connection" CD Offer, Peter Bertini, 20 Patsun Rd., Somers, CT 06071-1810 with a check or money order for \$15 enclosed. Readers outside the United States or Canada should first determine actual shipping costs by e-mail before attempting to order a CD.

In closing, here are the values of the caps show in **Photos D and E**. They are both mica (indicated by the first black dot.) The cap in **Photo D** is 1600 mmfd, and the cap in **Photo E** is 3900 mmfd. ■

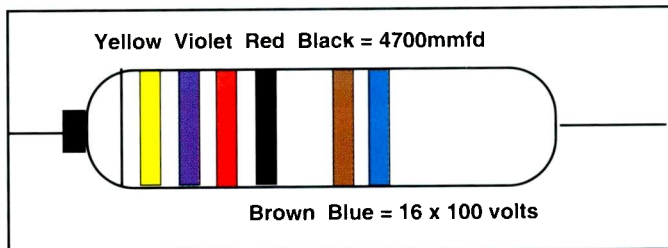


Figure 5. Pictorial for a .0047-mFd molded Bakelite tubular wax-paper bumble-bee capacitor.

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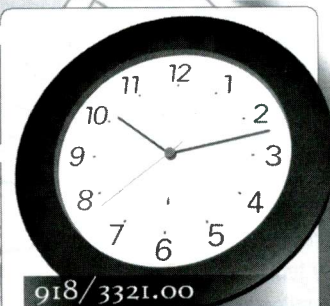
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